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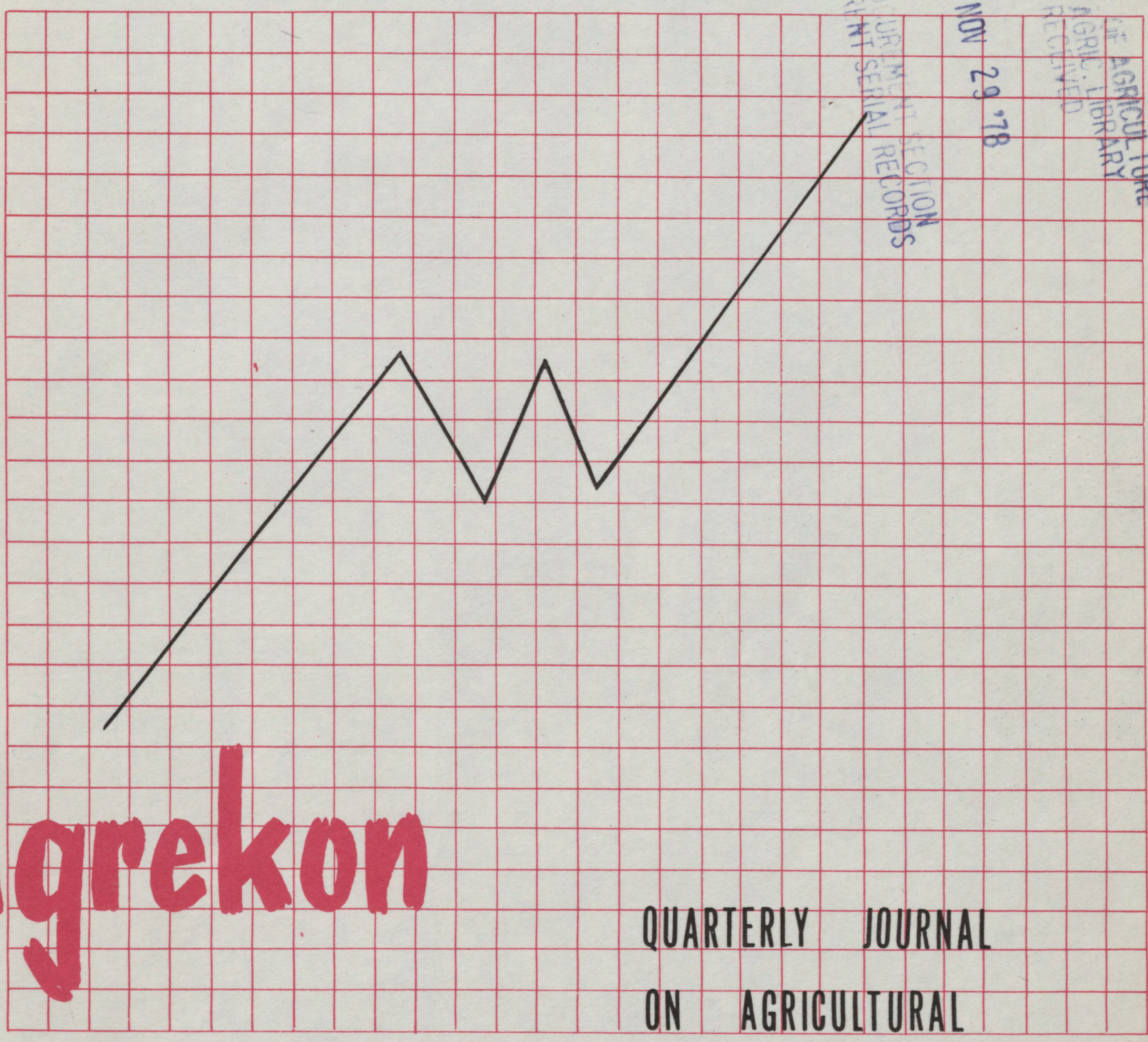

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MANAGEMENT INDICES FROM CROSS-SECTIONAL PRODUCTION FUNCTIONS: AN EMPIRICAL EVALUATION*

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1. INTRODUCTION

Farming efficiency is traditionally measured by residual and/or partial parameters. Examples of such parameters are legion - net income, operator's earnings, capital turnover rate, gross income per R100 of labour costs or per R100 of equipment costs, net income per hectare or per R100 of capital investment and many similar parameters are well known to any person who has studied literature on agricultural economics. It is also well known that all such parameters, because they are normally linked to specific inputs or otherwise ignore factors such as enterprise size or input combinations, are unsatisfactory in certain respects.

In a few recent studies a different approach has been used. Cross-sectional production functions were fitted and the actual results obtained in individual farm enterprises were compared with those expected according to co-efficients of the fitted functions. The point of departure in this approach is that a farmer who does better than would be expected according to a fitted cross-sectional function is in fact on a higher production function and is therefore more efficient.

Joubert and Viljoen[1] fitted Cogg-Douglas type functions to the gross income from crops in a sample of farmers in the North-Western Free State. The gross incomes actually obtained were expressed as percentages of estimated (expected) gross incomes and these percentages were defined as an efficiency index. It was found that the efficiency index so calculated exercised a strong negative influence on production costs of crops.

In another study made in Rûens Cobb-Douglas type functions were also fitted to gross farm income. The difference between the results actually obtained and those statistically expected was expressed as a percentage of results actually obtained and defined as a management index.[2] Further analyses were made to determine which factors influence the management index in that case.

The point of departure in both studies is briefly this: an entrepreneur with a high calculated index produces more from his total application of resources than is the case with an entrepreneur with a low index.

In this article an attempt will be made to test the validity of this approach in terms of traditional parameters. It is hypothesised that if the index so calculated reflects the same general trend as that provided by the more traditional parameters, it will serve as an illustration of the validity of such an index as a parameter of farming efficiency.

2. EMPIRICAL APPROACH

Cobb-Douglas type production functions, with gross farm income as a dependent variable, were fitted to data from a sample of 35 farm enterprises in that part of the southern Swartland delimited by Joubert[3] as a homogeneous farming region, with homogeneity, *inter alia*, in respect of soil and rainfall. Five functions were fitted. The independent variables consisted of alternative formulations of the inputs of soil, capital, operating costs and labour. The functions provided satisfactory fittings with co-efficients of

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determination that varied between 0,8979 and 0,9095. The test for the economies of scale in each case gave a t-value of less than 1,0 for the deviation from the sum of the co-efficients of 1,0. It is therefore accepted that constant economies of scale obtain.

From each function an index was calculated for each farmer as follows:

$$I = \frac{100\,(Y-\hat{Y})}{\hat{Y}}$$

Were I = index
Y = gross income realised
$\hat{Y}$ = expected gross income

The geometric mean of the five different values of I was accepted as the farmer's management index. A positive management index was considered to be above-average performance and a negative index to be below average. The management index so calculated varied between -41,4 and +46,3.

After this the sample was subdivided into three groups:

Group A (11 farmers) have indices of above +13,5

Group B (13 farmers) have indices that varied between +13,4 and -7,0

Group C (11 farmers) all have indices of less than -7,1.

The groups were compared as regards certain business characteristics. The t-test was used to evaluate the statistical significance of differences between the three groups.

3. FINANCIAL RESULT

The validity of the management index can probably best be tested by financial results. If it is accepted that the profit motive is an important incentive in farming - as in fact is implied by the traditional standards of measurement - higher efficiency should be reflected in higher profit.

A comparison between the three groups is given in Table 1. The absence of significant differences between the three groups in capital investment and total farming expences implies that there are no significant differences between the groups as regards scale of operation. Differences in average net incomes between the three groups therefore cannot be put down to possible differences in scale of operation.

It is apparent from Table 1 that group A produces the highest and group C the lowest average net income per farm enterprise. When the results are expressed per R100 of capital investment the same characteristic appears.

If it is accepted that the break-even point for acceptability of return to capital must be based on alternative possible earnings, this aspect has additional interesting implications. In the year covered by the surveys long-term interest rates on fixed interest-bearing investments varied in South Africa between eight and 10 per cent.[4] On this basis an investor could evidently hope to earn nine per cent if he invested funds of the scope indicated in Table 1 elsewhere. Judged against this yardstick, the average farmer in the sample (R10,05 per R100 of capital) did about 12 per cent better by farming for himself. The average group A farmer did 76 per cent better and the average group B farmer did 16 per cent better. Against this, the average group C farmer, by farming for himself, obtained a net income that was 57 per cent smaller than the same investment would have earned elsewhere. In other words, with an interest rate of nine per cent groups A and B showed positive operators' earnings, but group C's was negative.

However, it must be remembered that this profitability on capital is not comparable with the profitability normally calculated for industrial and commercial enterprises. In the latter case management salaries are included even in the case of one man businesses as a cost item before the profitability calculations are made. In addition, these figures represent the situation before tax.

4. YIELD PER UNIT

Higher efficiency, as reflected by higher production from a total application of resources, should also be reflected by higher partial efficiency in respect of at least certain resources. It has already been shown that in the southern Swartland it goes with a higher net income per R100 of capital.

A yield index, as described by Hattingh,[5] was calculated for each farmer. This yield index shows in terms of percentages how a farm enterprise compares with the average of a group (in this case the sample) as regards yields per hectare or per stock unit. Because group C's results are influenced by an exceptionally large pig farming enterprise that showed very poor results, the comparative figures in this case will be threefold: First for the whole farm enterprise, secondly for the farm enterprise, excluding the pig enterprise, and thirdly for pig enterprises only.[6]

These analyses appear in Table 2. It appears that the least efficient group, namely group C, produced poorer yield results throughout than the other two, according to the standards. The differences between groups A and B, on the other hand, are not statisitically significant.

Another approach was also followed in which gross production value, net farm income and total cost were expressed per primary productive unit. A primary productive unit is defined as a unit that makes a direct contribution to production. It therefore includes areas planted, but not areas of fallow land or "ouland". It also includes large stock units. In the absence of an objective basis for measuring potential contributions of large stock units and planted areas, each hectare planted and each large stock unit was equated to one primary production unit. The results appear in Table 3.

TABLE 1 - Financial results, three groups of farmers, southern Swartland, 1972/73

	Average value				t-value for difference		
	Group A	Group B	Group C	Sample	A-B	A-C	B-C
	R						
Net farm income	36 154	19 134	8 074	21 121	+2,495*	+3,796**	+2,291*
Net farm income per R100 of capital	15,82	10,46	3,87	10,05	+2,472*	+4,799***	+4,548***
Total capital investment	229 406	184 674	225 851	213 320	+1,006	+0,084	- 0,794
Total expenditures	38 959	29 262	34 668	34 270	+1,012	+0,327	- 0,478

*** : Significant at p=0,001
** : Significant at p=0,01
* : Significant at p=0,05

TABLE 2 - Yield indices, three groups of farmers, southern Swartland, 1972/73

	Average value			t-value for difference		
	Group A	Group B	Group C	A-B	A-C	B-C
Total farm	109,6	103,2	77,8	+0,475	+2,953**	+1,829(0,10)
Pig enterprise included	105,4	104,3	85,5	+0,078	+1,676(0,20)	+1,326(0,20)
Pig enterprise	174,8	69,0	42,6	+1,750(0,10)	+2,340*	+2,378*

** Significant at p=0,01
* Significant at p=0,05
(0,10) Significant at p=0,10
(0,20) Significant at p=0,20

TABLE 3 - Financial parameters per primary productive unit, three groups of farmers, southern Swartland, 1972/73

	Average value				t-value for differences		
	Group A	Group B	Group C	Sample	A-B	A-C	B-C
	R						
Gross production value	109,19	99,63	73,73	94,18	+0,847	+4,106***	+2,367*
Total cost (a)	51,27	55,12	48,80	51,73	- 0,474	+0,326	+0,730
Net farm income	57,92	44,51	24,93	42,45	+2,330*	+4,627***	+2,893**

(a) Interest excluded
*** Significant at p=0,001
** Significant at p=0,01
* Significant at p=0,05

It appears that total costs per primary production unit do not differ significantly between the three groups. The low t-value (less than 1,0) shows that, as regards total costs, the variance within each group is higher than between groups. On the other hand, however, gross production value per primary productive unit is significantly lower in Group C than in groups A and B. There is no significant difference in gross production value per primary production unit between groups A and B. This parameter therefore once again points to lower yields in the case of group C, the inefficient group.

As regards net income per primary production unit, group A fared significantly better than group B, and group A and group B did significantly better than group C. The difference in efficiency of application in costs is also evident from the fact that gross expenditures, expressed as a percentage of gross income, amounted to 47,96 in the case of group A, compared with 55,04 per cent in the case of group B and 71,47 per cent in the case of group C.

5. YIELD ON CAPITAL AND ON COSTS

It was indicated earlier in this article that there were differences between the three groups in respect of yield on capital and it was suggested that there are also differences in respect of yield on costs. These aspects will now be further analysed. In this analysis interest will not be included with costs.

For each farmer in the sample a capital yield index and a cost yield index were calculated as follows:

$$KI_i = \frac{\sum_{i=1}^{n} \frac{PVi}{PVi}}{\sum_{i=1}^{n} \frac{Ki}{Ki}} \times \frac{100}{1}$$

$$CI_i = \frac{\sum_{i=1}^{n} \frac{PVi}{PVi}}{\sum_{i=1}^{n} \frac{Ci}{Ci}} \times \frac{100}{1}$$

KI_i = yield index of farmer i

CI_i = cost yield index of farmer i

PV_i = production value of farmer i

K_i = capital investment of farmer i

C_i = total costs of farmer i

n = number of farmers in sample

A multiple regression fitting covering the whole sample was carried out with MI, the management index, as dependent variable and KI and CI as independent variables.

The results were as follows:

$MI = -81{,}177 + 0{,}277\ KI + 0{,}518\ CI$

$R^2 = 0{,}763$

Both regression coefficients deviated significantly from zero at $p=0{,}01$ and the high coefficient of determination indicates a good statistical fit between model and data. Single correlation coefficients were as follows:

$r\ bi.\ ki = 0{,}568$

$r\ bi.\ ci = 0{,}739$

The results therefore indicate a significant relationship between management index and both yield on capital and yield on costs. It is also apparent that the cost yield index has a greater effect on the management index than the capital yield index.

6. EVALUATION

The analyses offered in this article show that management or efficiency indices, as derived from cross-sectional production functions, in this case are a realistic parameter of farming efficiency if they are evaluated in terms of financial success and yields per unit. In view of the fact that such indices represent a more total analysis than partial or residual parameters, it must be accepted that this instrument of measurement deserves a place in farming efficiency analysis.

However, it should be used with circumspection. It can only be used if the following factors are present:

1. A large enough sample to fit significant cross-sectional production functions.
2. Adequate homogeneity in respect of natural resources and farming systems within the sample.
3. Constant or nearly constant economies of scale.

If rising economies of scale obtain, such an index would, however, overestimate the relative efficiency of larger enterprises and underestimate that of smaller enterprises. The opposite would hold with decreasing economies of scale. In such cases economies of scale would have to be quantified and management or efficiency indices would have to be adjusted accordingly.

This parameter also does not make provision for the effect of chance occurrences.

In spite of these possible problems, however, it is an instrument of measurement that inspires confidence.

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